

bromine, iodine, sulphur, potassium, sodium, lithium, silver, thallium, aluminium, carbon, phosphorus, barium, calcium, magnesium, and lead, and making a reasonable allowance for the errors of the determinations, he calculates the probability that nine of those numbers should lie, as they are found to do, within 0.1 of integers, supposing the value of the true numbers to be determined by chance, and finds it only as 1 to 235.2. The exact figure for the chance will of course depend upon the limit of error taken; but the above example seems sufficient to show that not only is Prout's law not as yet absolutely overturned, but that a heavy and apparently increasing weight of probability in its favour, or in favour of some modification of it, exists, and demands consideration.

IV. "On the Height of the Aurora Borealis." By WARREN DE LA RUE, M.A., D.C.L., F.R.S., and HUGO W. MÜLLER, Ph.D., F.R.S. Received April 22, 1880.

Our experiments on the electric discharge, which have been already published in the "Phil. Trans." and the "Proceedings of the Royal Society," enable us to state with some degree of probability the height of the Aurora Borealis, when its display is of maximum brilliancy, and also the height at which this phenomenon could not occur on account of the great tenuity of the atmosphere.

In Part III of our electric researches, "Phil. Trans.," p. 159, vol. 171, we have shown that the least resistance to the discharge in hydrogen is at a pressure of 0.642 millim., 845 **M**; after this degree of exhaustion has been reached, a further reduction of pressure rapidly increases the resistance. When the exhaustion has reached 0.002 millim., 3 **M**, the discharge only just passes with a potential of 11,000 chloride of silver cells (11,330 volts); at the highest exhaust we have been able to obtain (and which we believe has not been surpassed), namely, 0.000055 millim., 0.066 **M**, not only did 11,000 cells fail to produce a discharge, but even a 1-inch spark from an induction coil could not do so.

Although we have not experimentally determined the pressure of least resistance for air, we have ascertained that while the discharge occurs in hydrogen at atmospheric pressure between disks 0.22 inch distant, they require to be approached to 0.13 inch to allow the discharge to take place in air. We may therefore assume that the pressure of least resistance for air is

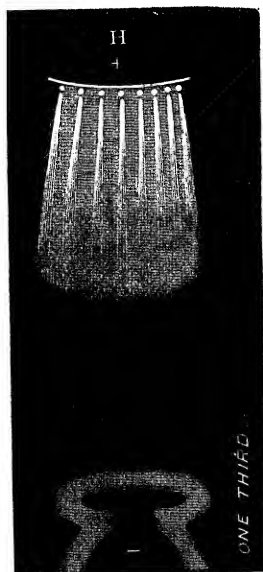
$$\frac{0.642 \times 13}{22} = 0.379 \text{ millim., } 498.6 \text{ M.}$$

At a height of 37.67 miles above the sea level, the atmosphere would

have this pressure (neglecting change of temperature), and therefore the display at this elevation would be of maximum brilliancy and would be visible at a distance of 585 miles.

The greatest exhaust that we have produced, 0·000055 millim., 0·066 *M*, corresponds to a height of 81·47 miles, and as 11,000 cells failed to produce a discharge in hydrogen at this low pressure, it may be assumed that at this height the discharge would be considerably less brilliant, especially in air, than that at 37·67 miles, the height of maximum brilliancy.

At a height of 124·15 miles the pressure would be only 0·00000001 millim., 0·00001 *M*, and it is scarcely probable that an electric discharge would occur with any potential conceivable at such a height.



The colour of the discharge varies greatly with the tenuity of air or other gas with the same potential. Thus in air at a pressure of 62 millim., 81579 *M*, the discharge has the carmine tint which is so frequently observed in the display of the Aurora; this corresponds to an altitude 12·4 miles, and would be visible at a distance 336 miles. At a pressure of 1·5 millims., 1974 *M*, corresponding to a height of 30·86 miles, the discharge becomes salmon coloured, having completely lost the carmine tint. At a pressure of 0·8 millim., corresponding to 33·96 miles, the tint of the discharge is of a paler salmon colour, and as the exhaust is carried further it becomes a pale milky white. The roseate and salmon coloured tints are always in the vicinity of the

positive source of the electric current, the positive luminosity fades away gradually, and frequently becomes almost invisible at some distance from its source; as, for instance, in the hydrogen discharge at a pressure of 2·3 millims., 3027 **M**, shown in the accompanying figure, H, which resembles in some respects the phenomena of the Aurora. The discharge at the negative terminal in air is always of a violet hue, and this tint in the Aurora indicates a proximity to the negative source.

The following table, with the exception of pressure 0·00000001 millim., exhibits deductions from actual observations.

Pressure mm.	Pressure M .	Height miles.	Visible at miles.	Remarks.
0·00000001	0·00001	124·15	1061	No discharge could occur.
0·000055	0·066	81·47	860	Pale and faint.
0·379	499·0	37·67	585	Maximum brilliancy.
0·800	1053·0	33·96	555	Pale salmon.
1·000	1316·0	32·87	546	Salmon coloured.
1·500	1974·0	30·86	529	" "
3·000	3947·0	27·42	499	Carmine. "
20·660	27184·0	17·86	403	"
62·000	81579·0	12·42	336	"
118·700	156184·0	11·58	324	Full red.

It is conceivable that the Aurora may occur at times at an altitude of a few thousand feet.

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